HSIS

Highway Safety Information System

SUMMARY REPORT

GIS-Based Crash Referencing and Analysis System

A geographical information system (GIS) can be simply defined as a collection of hardware and software that is used to edit, analyze, and display geographical information stored in a spatial data base. In recent years, many transportation departments and other related organizations, such as the Federal Highway Administration (FHWA), have examined the feasibility of using GIS for transportation planning, systems management, and engineering applications. In some States and municipalities, GIS is being used to plan transportation routes, manage pavement and bridge maintenance, and perform a variety of other traditional transportation-related functions. One area where GIS has yet to be extensively applied is in the analysis of crash data.

Computerized crash analysis systems in which crash data, roadway inventory data, and traffic operations data can be merged are used in many States and municipalities to identify problem locations and assess the effectiveness of implemented countermeasures. By integrating this traditional system with a GIS, which offers spatial referencing capabilities and graphical displays, a more effective crash analysis program can be realized. The objective of this effort was to develop a crash referencing and analysis system within a GIS.

The Highway Safety Information System (HSIS) is a multi-State safety data base that contains accident, roadway inventory, and traffic volume data for a select group of States. The participating States, California, Illinois, Maine, Michigan, Minnesota, North Carolina, Utah, and Washington, were selected based on the quality of their data, the range of data available, and their ability to merge data from the various files. The HSIS is used by FHWA staff, contractors, university researchers, and others to study current highway safety issues, direct research efforts, and evaluate the effectiveness of accident countermeasures.

DATA BASES USED

The system was developed using the Highway Safety Information System (HSIS) for North Carolina for the area of Wake County. It provides the functions needed to edit tabular and spatial crash and roadway data and to perform crash analysis. The HSIS data bases incorporated into the system include the crash and roadway inventory files. Additional data bases maintained by the North Carolina Department of Transportation (DOT) that were integrated into the system included the traffic signal inventory, pavement management/condition inventory, railroad grade crossing inventory, and the average daily traffic file. Also included in the system are data bases that are not traditionally used in safety analyses, such as the land-use and zoning ordinance files for Wake County and the TIGER census files containing population and demographic information.

SYSTEM DESIGN

With built-in GIS functionality and the ability to customize the graphical user interface, ArcView GIS was chosen as the primary software for the system, with ARC/INFO as a supplement.[1] The system includes a user interface that allows data to be entered, edited, analyzed, and exported to other applications. It also features graphical displays,

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point-and-click selections, pull-down and pop-up menus, the ability to view multiple windows concurrently as shown in **figure 1**, and a minimum number of typed command requirements.

The system is designed with three principal functions: file/report management, crash location editing, and data analysis. Management tools allow for the import and export of data files, viewing and extraction of analysis reports, and deletion of files and programs used in previous analysis efforts. The editing function is provided to handle crashes that have been mileposted incorrectly or not mileposted at all. The user can select the crash to be mileposted and through the graphical interface simply position the crash at the correct location using the mouse.

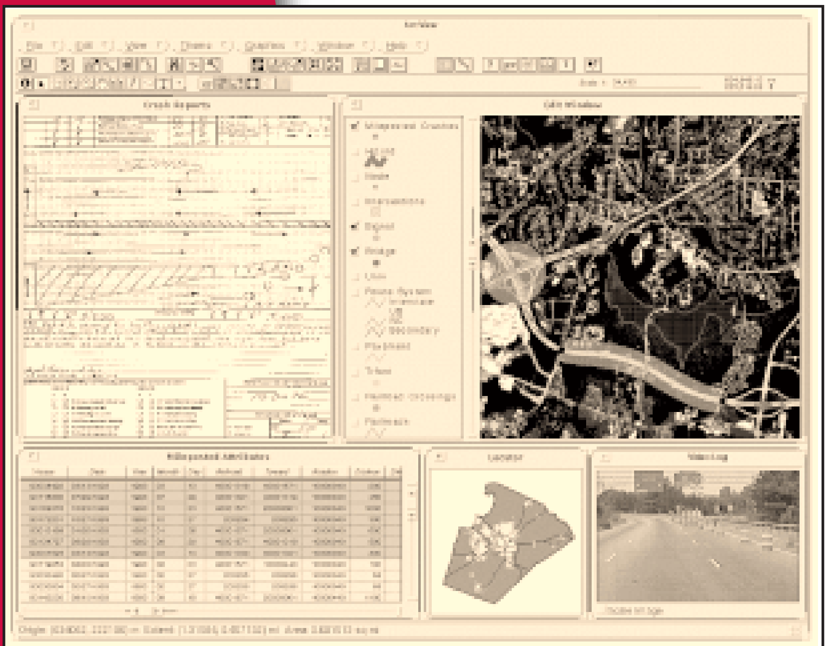

Figure 1. The GIS-based crash referencing and analysis system.

The system is also supplemented with the capability of viewing scanned crash reports and videologs. The crash report viewer allows the user to examine images of reports, including narratives and collision diagrams, that have been scanned into the system, and includes zoom and pan capabilities. The videolog viewer allows the user to enter a route and milepost, and to access the video images for that location. These images were obtained for both directions of travel and can be used to assess geometric features, signs and markings, and other relevant information.

CRASH ANALYSIS TOOLS

The analysis tools include five separate programs to evaluate crashes at designated spots or intersections, along specific roadway segments or strips, clustered around a specific roadway feature, or within a defined corridor. All of the programs allow the user to produce results for all crashes or for a given subset of crashes that can be defined using any of the variables contained in the crash and roadway inventory files. For example, if the analysis issue of interest involved only nighttime crashes, the light condition variable could be used to include only those crashes occurring when it was dark. The user can also perform additional ad hoc queries using the analysis and mapping tools in ArcView.

The ***Spot/Intersection Analysis*** program is used to evaluate crashes at a user-designated spot or intersection within a given search radius. The end result of this analysis is a report that lists the number of crashes by injury severity, crash cost, and other variables designated by the user. A graphic depicting the spot or intersection, search radius, selected crashes, and roadway identifiers is also produced and can be output as a hardcopy map as shown in **figure 2**.

The ***Strip Analysis*** program is used to study crashes along a designated length of roadway as opposed to a spot or intersection. The user must enter the route(s) of interest and the length of the segment to be used in the analysis. For example, if the user input 0.50 km as the segment length, the program would analyze each consecutive 0.50-km segment along each route, from 0.00 to 0.50, 0.51 to 1.00, etc. The end result of this analysis is a report with similar output to that produced for the intersection analysis and a graphic that can also be output as a hardcopy map depicting the strip, selected crashes, and roadway identifiers as shown in **figure 3**.

The ***Cluster Analysis*** program is used to study crashes clustered around a given roadway feature such as a bridge, railroad crossing, or traffic signal. Crashes within a user-defined distance of a feature are identified on all routes selected. If the number of crashes found is equal to or greater than the user-defined minimum threshold, the location is flagged and included in the results. The analysis report lists various summary statistics based on user inputs and produces a graphic that can be printed as a hardcopy map depicting the high crash locations.

The ***Sliding-Scale Analysis*** program is used to identify roadway segments with a high crash occurrence. This program differs from the Strip Analysis program in that the analysis segment is not fixed, but rather slides along the route in an incremental fashion. The user defines the segment length and the increment length for analysis. For example, if the segment length is defined as 0.50 km and the increment length is 0.10 km, the program starts at the beginning of a route and analyzes the first segment from 0.00 to 0.50 km, then slides 0.10 km and analyzes the second segment from 0.10 to 0.60 km. If the crash rate of any strip meets or exceeds the user-defined threshold, the segment is extended by the incremental distance, and the process is repeated. A segment is ended when the maximum milepost of the route is reached or when the user-defined number of allowable extensions without a crash is exceeded. Based on other user-defined parameters, intersections can either be ignored, excluded based on a buffer around each intersection, or included without any buffer and inclusive of crashes within a specified distance on intersecting routes. The end result of the analysis includes a table showing the high crash locations, along with a variety of summary statistics and a map showing these locations.

The ***Corridor Analysis*** program is used to locate high crash concentrations within a corridor. Using traditional methods, segments along a specific route could be examined (e.g., by using the Sliding-Scale Analysis), but multiple routes within a corridor could not be easily linked and analyzed as a group. This program allows routes to be linked together in a manner that allows the analyst to assess the overall safety performance within a transportation corridor. In this current effort, the program was used to examine truck crashes along designated truck corridors in Wake County. State laws permit trucks to drive on any designated truck route and along any intersecting routes for a distance of up to 3 mi (4.8 km). These routes and distances define the truck corridors. Using the Sliding-Scale Analysis program and the Corridor Analysis program developed to identify truck crashes within the 3-mi (4.8-km) driveable zones, high truck crash zones within the corridors were identified. The output of the analysis included crash statistics and a variety of roadway characteristics for each high crash zone in the corridor. In addition, a plot depicting the roadways included and the crash locations in each zone was also produced. A future HSIS summary report will provide a complete overview of the truck corridor study.

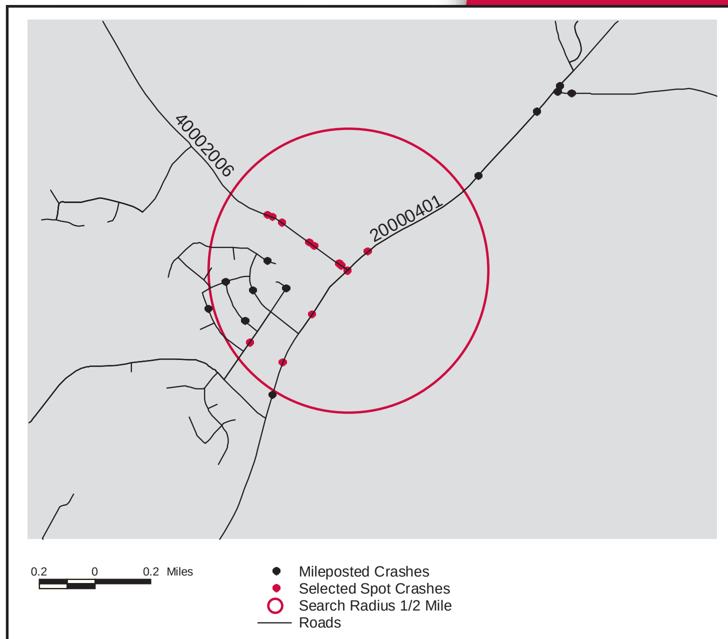

Figure 2. Results from the ***Spot/Intersection Analysis*** program can be graphically displayed as shown here.

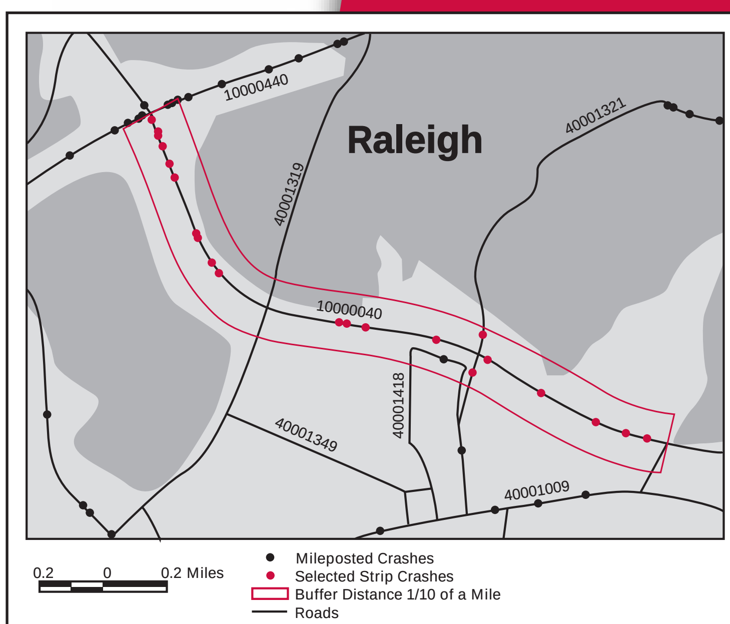

Figure 3. Results from the ***Strip Analysis*** program can be graphically displayed as shown here.

This GIS-based crash referencing and analysis system enhances the capability of engineers to conduct problem identification and countermeasure evaluation studies. Specifically, the advantages of this system over the more traditional referencing and analysis methods include the ability to:

- Quickly milepost a crash that was mileposted incorrectly or had no milepost provided.
- Evaluate the problem using the spatial relationships available from the graphical displays compared to the traditional methods of tables and plots.
- Produce presentation graphics and descriptive plots from within the software as opposed to exporting results to another software package for such production.
- Develop an on-line capability to respond to concerns and questions about specific locations.
- More accurately report crashes and roadway features when combined with global positioning system (GPS) technology, thus making the analysis more reliable.
- Conduct corridor analyses by automatically linking adjacent or nearby routes together within defined zones.
- Incorporate non-traditional data bases that are available within GIS, such as land use, zoning ordinances, and population characteristics, into problem identification and evaluation studies.

In addition, the system allows traffic engineers to access various types of supplemental information without leaving their desks. Scanned versions of an officer's handwritten crash report can be examined to provide detailed information that may not be contained in the crash event table. Routes and crashes can be overlaid with scanned aerial photography to provide the engineer with a better understanding of the development and roadway configuration of a particular study area, and images from the videolog can be scrutinized to provide an even more detailed view of the roadway. Various attribute tables can be created, edited, and linked to other tables, providing even more flexibility and power. All of these tools combine to form a system that makes locating, editing, and analyzing crashes and other spatial data faster and more efficient.

FUTURE DEVELOPMENTS

Recently, FHWA initiated a study to expand on the current effort conducted in North Carolina to further develop, test, and integrate the GIS-based crash referencing and analysis system in other HSIS States. The GIS capabilities of these States are being examined and the feasibility of integrating the developed system into the State data bases is being explored. Work is also underway to develop GIS analysis tools to improve pedestrian and bicycle safety. The pedestrian application involves the development of a system to identify safe routes to school, and the bicycle application is exploring the use of GIS to assess the bicycle compatibility of roadways.

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REFERENCE

1. ArcView GIS and ARC/INFO are GIS software packages developed by Environmental Systems Research Institute, Inc., Redlands, California.

FOR MORE INFORMATION

This system was funded by FHWA and was developed by the North Carolina Center for Geographic Information and Analysis, with technical assistance from the North Carolina DOT and the University of North Carolina Highway Safety Research Center (UNC-HSRC). For more information about the system, contact David Harkey, UNC-HSRC, at (919) 962-8705.
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